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A Monthly Review of Meteorology, Medical Climatology and Geography.

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Ann Arbor, Mich., Oct. 1st, 1884. Steward of the University.

THE AMERICAN

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VOL. II. ANN ARBOR, DECEMBER, 1885. No. 8.

CURRENT NOTES.

NANTUCKET CABLE.—A weather bureau cable is to be laid between Nantucket and Martha's Vineyard shortly, and may have been already completed by the time this paragraph meets the reader's eye. Marine news from Nantucket can then be telegraphed to the mainland, and this island will be no longer isolated from the rest of the world for a not inconsiderable part of the year.

AMERICAN PUBLIC HEALTH ASSOCIATION.—This thriving association held its meeting December 8, 9, 10 and 11, in Washington. This is its thirteenth meeting, and was a very interesting one. The association has now a large membership drawn from all classes interested in public health. The membership is largely made up of physicians, but includes clergymen, lawyers, teachers, and philanthropists, generally. The annual fee is five dollars, and the only requirement for admission is an acknowledged interest in questions of public health.

A PROBLEM IN GEOGRAPHICAL DISTRIBUTION.—Limnaea humilis was collected by the hundreds in April, 1885, in a small artificial pond in the vicinity of Todos Santos bay, Lower California. The pond was nearly ten years old, a few inches deep and about six feet across, fed by a windmill from a well twenty feet deep. For miles there is no surface water naturally and it was a great surprise to find this mollusk in such a location. How came it there? —*West Am. Scientist.*

A PRIZE.—The medical school at Harvard University offers two prizes annually. The first prize for the current year is on a subject of interest to sanitarians and meteorologists. Its amount is 350 dollars, and the subject on which the dissertation is to be written is, *The Influence of the Soil as a Factor in the Causation and Spread of Typhoid Fever.* The essays must be accompanied by no clew of authorship, except a cryptograph with a key in a sealed envelope. They must reach Morrill Wyman, M. D., 24 Church street, Cambridge, Mass., on or before April 7, 1886.

THE CUTTER CORWIN.—The U. S. revenue cutter Corwin arrived at San Francisco, October 12, from Alaska. We clip the following account of her trip from the California papers. "She had nearly 200 of the crews of shipwrecked whalers aboard. The Corwin brought news from the Arctic fleet to the 20th of August. On July 1st the Corwin arrived at Kotzebue sound, whence two exploration parties were sent out—one under command of Lieutenant Cantwell, to proceed up Kowak river; the other under Assistant Engineer McLannegan, to proceed up the unexplored Nowatak river. The Corwin then continued northward, coaled at Cape Sabine, August 17th, turned her course southward, and arrived at Hopham inlet August 27th, where she found both exploring parties, which had returned after having successfully executed their tasks. McLannegan, who had explored the Nowatak river, reports having met Lieutenant Stoney and party at the upper head of Hopham inlet. Stoney was just about to start for the interior. The Corwin brought the mail from Stoney's party. The vessel left the Arctic August 28th, arrived at St. Michaels September 24th, and found there Lieutenant H. F. Allen, Sergeant Robertson and F. W. Ficket, of the United States Signal Corps, comprising the party sent out last year by General Miles to explore Copper river and the region between it and the Yukon river. Here they also found two English tourists, J. W. Garland and F. R. Beatty, who had made a remarkable trip from Great Slave Lake across the Mackenzie river to the Yukon river, and down the latter to St. Michaels. Both parties were taken aboard and brought here. September 8th the Corwin anchored off Hall's Island, where a 1600-pound polar bear was shot and killed. It will be sent to the

Smithsonian Institute. October 1st the vessel finally left Ounalaska for this port. During the trip the health of all has been excellent, and there have been no accidents.

A MINIATURE VOLCANO.—A miniature volcano has been added to the laboratory of the Keystone Normal school, where it will hereafter be used for purposes of instruction. It was formed spontaneously at the Macungie furnace, in Lehigh county, on the top of a car of melted iron cinders. As the extreme crust of the slag cooled and consequently contracted, the interior gases, cramped for room, burst out at the surface in jets and spurts as in a natural volcanic eruption, and proportionately quite as high, gradually forming the frustrum of an irregular cone, with an opening in the center from bottom to top. Through this opening the melted matter was forced up from the mass below, running over at the top of the cone on all sides and dripping downward, cooled into beautiful stalactical forms. After the gases had become exhausted an opening was made near the base of the cone, giving another outlet to the matter left in the crater, which left the opening in the cone clear and comparatively smooth. The height of the cone is 20 inches, outside diameter at bottom 15 inches, and at the top 5 inches. Its growth occupied half an hour. Its weight is 90 pounds. This is a good illustration of the manner in which volcanic peaks are supposed to be naturally formed, confirming the theory that, as the crust of the earth contracts by cooling, the interior gases and melted matter requiring more room, mountain ranges are raised, and, at the weaker points, openings are forced, from which the imprisoned matter escapes and volcanic peaks and craters are formed, just as in the specimen above described.—*Lancaster (Pa.) Era.*

NOVEMBER TORNADOES.—They are not usual and are generally isolated. This year, however, a general tornadic condition covered a large part of the states. Tornadoes occurred on the evening of the seventh of November in Texas. The one in Cass county was very destructive, resulting in the loss of several lives and much property. The spiral cloud was distinct and the path about thirty yards wide.

On the evening of the eighth two destructive tornadoes swept through Illinois. The one passed near Bloomington from Pike to McLean county. Its course was about 100 miles which it traveled in three hours. The other was about 200 miles to the southward in the Wabash Valley.

On the night of the eighth, a very destructive tornado passed just north of Selma, Alabama. The track was half a mile wide. Thirteen persons were killed outright and many injured.

THE ALABAMA WEATHER SERVICE.—This service is doing good work. The railway weather service is being rendered more and more efficient. As an interesting contribution to popular education we clip the following definition from one of its cards intended for general distribution over the state:

> The terms "Cyclone" and "Tornado" must not be confused. The first indicates a great storm moving the air particles towards the centre of the disturbance in great circuits, the diameter of which is sometimes hundreds of miles in extent.
>
> Tornadoes are local disturbances in a Cyclone. Sometimes near the centre of a great storm, or Cyclone, the general inward tendency of the air causes a violent whirlwind where the air revolves with such violence as to prostrate houses and trees and carry heavy objects to great distances—this is a Tornado. Its duration at any one place scarcely exceeds more than one minute, and the width of the path is seldom more than one hundred yards.

Anything that will tend to prevent the absurd popular misuse of the terms tornado and cyclone is especially welcome.

A new departure for this service, and one showing great enterprise, is the publication of special articles on questions relating to Alabama. The first one of this series is Captain W. H. Gardner's *Record of the Weather from* 1701 *to the Present Time.* This relates to the South and is an interesting and valuable compilation of fifteen octavo pages and must have required much labor. It can probably be obtained through the director of the service, Professor P. H. Mell, Jr., Auburn, Alabama.

METEOROLOGICAL OBSERVATORIES IN URUGUAY.—The Italian Meteorological Society occupies this field and reports the foundation of two new stations of the second order. One is at Paysandu,

the other at San Nicolas de Los Arrogos. D. Domenico Albanello is director of the Central Meteorological Observatory of the Collegio Pio di Villa Colon at Montevideo, and will be in general charge of the new stations. Uruguay, or as it is now called Banda Oriental, is said to have a climate near perfection. Should this be true it will no doubt soon be proven to the satisfaction of every one by precise observations.

The Italian Society has reached far out from home. It has recently established two stations in Patagonia. One is at Punta Arenas on the Straits of Magellan, the other at Carmen di Patagones. Both are under the control of Salesian missionaries, who have been instructed at Moncalieri.

A PRIZE FOR WORKS OF PURE METEOROLOGY.—The General Assembly of the Italian Meteorological Society offered in 1882 a prize of 500 *lire* for the best work on meteorology applied to agriculture, and another of equal amount for the best work on pure meteorology. The latter prize was given to Professor Domenico Ragona, Director of the Royal Observatory at Modena, and a prolific meteorological writter. No work, of those entered, was considered worthy of the first prize, and, we understand, it is still open. The Italians give us many examples, of late years, worthy of being followed, and the above is not the least worthy.

ELECTRICAL CONDUCTIVITY OF CLOUD MATTER.—In a late number of the Journal, a correspondent raises the question of the electrical conductivity of a cloud mass. The theory, which he refers to is one advanced by H. Pellat, in the Journal de Physique, Jan. 1885, translated for the Journal. The theory does seem to require the assumption that a cloud is a sufficiently good conductor to have little difference of potential at different parts, and it is therefore pertinent to call for the experimental truth of this assumption. There are but few observations bearing on the matter. Sir William Thomson, in his electro-statics states that fogs are highly positive, but does not state whether or not the fog bank is in contact with the earth. If it were, it is certain evidence that fog matter which is the same as cloud matter, is not a good electrical conductor. Steam from a kettle boiling briskly, we know to be an

excellent insulator,* while common air, above certain temperatures loses all its resisting power. Pöey† discusses at length, the structure and electrical character of thunder clouds, explaining the distribution of the electricity. He considers a cloud mass to be unlike a metallic body, with a continuous surface, and a certain distribution of the electricity there. In the case of the cloud, the charge on the outer envelope is but a part of the quantity held in the cloud. This exterior charge is replaced after each discharge, at the expense of the charges of the drops or corpuscles. Pöey then describes in detail the constitution of the cloud mass, and after showing how the manner of grouping of the small particles determines the character of the cloud—whether Fracto-Cumulus, Cumulus, or Pallium, goes on to say that‡ "we must consider clouds as collections of *individualities* having their own independent electrifications, in equilibrium among themselves and in equilibrium with the exterior distribution. It thus follows that the cloud has two sets of electrifications, and acts in two ways on the surrounding atmosphere and neighboring bodies, one arising from the quantity of electricity accumulated on the surface; and the other from the electricity resident on each particle. The former gives the lightning." Such are Pöey's views and they seem unfavorable to the assumption that a cloud is a good conductor. On the other hand, I believe it is generally the case that during prevalence of fog there is little difference of potential between a plate exposed a certain distance from the ground in the fog, and the ground.

Some Miscellaneous Suggestions.—About two centuries ago Pascal and some others found that their barometers were occasionally luminous. In the latter part of the seventeenth century Borelly, then professor at Gröningen, investigated the phenomenon and called it the new phosphorus. He found that mercury, when kept very clean, and put in a glass tube free from grease and moisture, and with the atmosphere exhausted as highly as possible, was luminous on the slightest motion and with vigor-

*Sir Wm. Thomson's "Electro-statics and Mag." Note to P. 297.

†Pöey "Comment on observe les nuages" pp. 149 et seq.

‡Ib., p. 150.

ous shaking gave out a light by which faces of bystanders could be distinguished. It is now known that this is not a luminous property of mercury—a new phosphorus—but is an electric phenomenon of the same character as those in highly rarified tubes. As applied to barometers, it seems to have dropped out of sight, but cases could be easily imagined in which it might be useful in such instruments. It would, at least, prove that in the instrument where this phenomenon could be obtained, the mercury was very clean and the vacuum nearly perfect.

It is sometimes very desirable to be able to take notes in the dark. We take the following composition for a luminous paper from a contemporary which attributes it to *L'illustration*. Take of ordinary paper pulp, forty parts, of water ten parts, of phosphorescent powder ten parts, of gelatine and bichromate of potash, each one part, and make the paper from this compound. The phosphorescent powder consists of the sulphides of calcium, barium and strontium, well ground and thoroughly mixed. Such paper should be impermeable to moisture, but should be bright enough to have any writing on it legible in the dark.

A very pretty study, and one having its bearings on meteorology is that of vortex rings. Besides the remarkable features of the vortical motion, vortex rings are very delicate explorers of the state of the atmosphere as to rest, motion, or layering in a confined space. Very beautiful vortex rings are made from phosphuretted hydrogen by a method generally described in the chemistries. Locomotives sometimes make magnificent rings several feet in diameter, and the practised smoker can produce them. They can be made in profusion and quite perfect when a box of small size (a collar or envelope box), having an orifice an inch or so in diameter at one end, is filled with smoke, and puffs expelled by tapping or pressing on the cover. The smoke may be produced from dampened paper or tobacco, or the salammoniac fumes from ammonia and hydrochloric acid may be employed. An especially interesting form of the experiment is produced by dropping the solution of permanganate of potash in water. The larger and deeper the vessel of water, the more striking the results.

Spectroscopes would undoubtedly be more often employed in meteorology if they were cheaper and more easily obtained. Sr.

Govi shows, says an exchange, how they can be made and used without prisms or screens. A very high dispersive medium, (disulphide of carbon, oil of cassia, heavy flint glass), is placed between two plane, parallel surfaces. Internal dispersion, it is said, then brings out the Fraunhofer lines as distinctly as they can be shown by prisms. If this is true there is no reason why spectroscopes may not be as common as pocket magnifying glasses.

Problems of the Great Lakes.—The Great Lakes present many interesting features, some of which do not seem to have been yet discussed. There are many reports of sudden changes of level on them, the explanation of which, and even the fact of their existence, are not yet certain. In the summer of 1884 a steamer reported being passed by a long wave on a calm sea near the middle of Lake Huron. The report was that the wave was several feet high, extending as far as the sight could reach, and passed along rapidly. Similar sudden changes are sometimes observed on shore. These are evidently the *seiches* of the Alpine lakes, of which much is now known, but their study on the Great Lakes deserves the careful attention of those favorably placed to pursue it.

The dunes are found well developed on some parts of the shores of the Great Lakes. I have seen them best developed on the east and south shores of Lake Michigan. I have been informed that they show considerable travelling power and that at Grand Haven the railway station was so invaded by them that it had to be removed. There is an immense dune at Michigan City on the west side of the river mouth. It is in full view from the cars of the Michigan Central Railroad and is familiar to all travellers over the road. It shows some spreading power and is gradually invading the huts at its base. The territory covered by the dunes of the Great Lakes and their changes deserve study and publication.

There are many peculiar features of the climate of the Great Lakes. Many years ago Prof. A. Winchell, LL. D., studied the effects of the lakes on the isotherms for the months and year and his interesting results were extensively published. There are many other points of view from which the climatal effects of the

lakes are instructive. For instance, they must have an effect on the storm-areas passing over them, but this effect has not yet, so far as I know, been formulated.

The flora, in some sort, integrates the climate, to use a mathematical metaphor. It is a curious fact that the flora of the east shore of Lake Michigan is decidedly more southern in character than that from Saginaw Bay southward. The honey locust, the Judas tree, the paw-paw, reach well northeast on Lake Michigan, as high as Grand Rapids, while in the eastern part of the state they run out below Detroit. The flora of Niles approaches that of the Wabash Valley, being decidedly more southern in its character than that of Ann Arbor.

Another curious feature of the Great Lakes is the presence of islands of more arctic flora at widely distant and unconnected points. Many of the swamps of Southern Michigan have layers of sphagnum and furnish specimens of those beautiful orchids, *arethusa bulbosa* and *colopogon pulchellus*, which one would find much better at home north of Lake Superior and Lake Huron. Were these islands left behind in cold damp places on the retreat of the last cold cycle toward the Arctic regions? Are they remnants of a former much colder and, geologically, not very distant age?

The material is not lacking for a study of the character of the climate preceding the present one, the climate in the times when the clay-beds were deposited, which are now being eaten away by the waves. The falling banks often expose massive trees, apparently cedars, certainly coniferous, and sometimes the bones of early deer. This clay, too, contains an abundance of minute vegetable structures, probably seeds. A careful study of them would lead to interesting and important conclusions concerning the climate when they are deposited.

Characteristics of Whirls.—Our present mathematics is not able to make a complete solution of whirls, but many of the most important of their principles have been solved. The literature on them is fragmentary and somewhat inaccessible, and we take the opportunity to reproduce M. H. Faye's brief *resume* of their leading characters. The *resume* was made apropos of the nature of sunspots, and classified with reference to the analogies of the

latter phenomena. They can be easily tested by experiment, and, in view of the character of aerial cyclonic circulation, they are of great importance to meteorologists. Their characteristics are as follows:

1. Seen from above, their opening is circular.

2. The opening is broadly conical, like a funnel, directed vertically.

3. Seen in elevation, their contours are those of a surface of revolution, of which the meridian curve turns its concavity down, and of which the axis is vertical.

4. The gyration augments in rapidity with the contraction of the spirals. Very slow at the margin of the opening, the speed becomes excessive at the point to which is transmitted and accumulated all the vis-viva stored up in the upper reservoir.

5. Terrestrial whirls are of all imaginable dimensions, from a diameter of a few centimetres to hundreds of kilometres.

6. They are descending. The lower end of a whirlpool descends in proportion as the vis-viva stored up above at the opening, is great. The lower end rises, the whirl shortens vertically when this vis-viva diminishes.

7. A whirl can convey to its point objects ten, a hundred, a thousand times as light as the fluid of which it is formed.

8. If it meets a solid obstacle or layers of too great density, it exhausts against this obstacle, in performing a definite amount of work, the vis-viva stored up above. It abandons, at contact with this obstacle, the fluids or light bodies which it has drawn down.

9. These fluids or the light bodies then rise, tumultuously or in bubbles, around the whirlpool, on account of their specific lightness. In this way a persistent whirl becomes the means of a circulation, regular and downwards within, diffuse and from below upon the outside.

10. If the fluids brought with it have a lower temperature than the general medium, the whirl produces, in and around itself, along its path, a more or less sensible lowering of temperature.

11. To these characters which are easy to prove experimentally, it is necessary to join others possessed by whirls which have a progressive motion. They are produced spontaneously in currents at the expense of inequalities of velocity in parallel threads of the fluid and follow the threads with a velocity somewhat less

than the mean of those of the threads. These are facts of observation and can be best seen at the time of floods.

12. The most striking character of aerial whirls is their tendency to extend and grow when there is an increase in the difference of velocity in the superior currents where they rise. They then divide into partial whirls, originating in one funnel. From two to fifteen or more may hang down from the same cloud and may either separate from each other or flow together. To an observer situated above there would be only one immense obscure mouth, passing into a cylindro-conical tube which ends in several segmentations.

It should be noted that the hollow part of a proper whirl is different from that formed by a liquid surface when its receptacle is set in rapid rotation. The latter has a parabolic, the former a conical form. In the latter the velocity of each particle is as the distance from the axis of rotation. In the latter inversely as the square of this distance.

REVIEW OF EUROPEAN WEATHER FOR SEPTEMBER.—*Barometric pressure.* On the 1st and 2nd are two depressions one in the N. E near Stockholm, and another west of Ireland, separated from each other by a maximum over Germany and Holland, but on the 3rd the first minimum travels into Russia, and the high pressure to the S. E., while a part of the depression in the N. W. has moved to Denmark, and has disappeared on the 7th near the Norwegian coast; the main minimum, however, now travels easterly, and becoming less intense is situated on the 8th near Holland with precipitation and thunder storms; another minimum appears in the N. W. The first disturbance over Holland is now central near Memel on the Baltic coast, and spreads as an area of low pressure over Germany and Austria; over France appears a high pressure, while another remains stationary over Russia. Travelling N. E. the disturbance over the Baltic shores has disappeared on the 13th, but that in the N. W. moves also N. E., and on the 15th is situated near Bodo, on the North Norwegian shore; another rapidly follows and on the 16th has reached also the coast of Norway between Bodo and Christiansund. The high pressure over France has by this time spread over Germany and Austria

with calm clear weather. Another follows the disturbance just spoken of, and spreads over Britain, but rapidly descends to Southern France and Spain on the approach of a very intense minimum on the N. W. shores of Scotland, where the barometer has fallen to 29.10 (0.9 inch in 24 hours), with severe storm and considerable precipitation; as the former minimum this disturbance travels N. E. and has reached on the 21st the North Scandinavian shore with a partial depression on its southern side (or Denmark). On the following day this latter depression has reached Petersburg while the first has disappeared and another is observed N. W. of Scotland. The maximum in the South again spreads over Central Europe to Denmark, with foggy or clear weather; the minimum in the N. W. has by this time reached Finland, and a high pressure now advances from the S. W., while the disturbance in the N. E. spreads over Central Europe to Southern Italy, causing general rainfall. This area of low pressure encloses several minima; one over Finland, one over South Sweden, one over North Norway, and another over Italy. The high pressure in the West descends on the 28th to S. W. France and an intense minimum approaches in the N. W. with a barometer stand on the 30th below 28.8 in the centre; of the area of low pressure over Central Europe rests by this time only one minimum over Russia.

Temperature: Germany.—Below the mean 1–6, 11–14, 23, 25–30, above the mean 7–10, 15–22, 24; lowest 36° at Munich on the 24th, highest 84° at Breslau on the 16th.

Valentia: Ireland.—Below the mean 3–4, 7, 9–11, 15, 21–27, 29–30, above the mean 1–2, 5–6, 8, 12–14, 16–20, 28; lowest 42° on the 27th, highest 64° on the 8th.

Petersburg: Russia.—Below the mean 1–15, 20, 23, 25–30, above the mean 16–19, 21–22, 24; lowest on the 28th 35°, highest 59° on the 9th.

Stockholm: Sweden.—Below the mean 1–4, 6, 10–12, 19–20, 24–30, above the mean 5, 7–9, 13–18, 21–23; lowest on the 27th 37°, highest on the 16th 68°.

Hoparanda: Lapland.—Below the mean 6, 8–15, 17–20, 22–30, above the mean 1–5, 7, 16, 21; lowest on the 26th, 27th, and 30th 32°, highest 57° on the 3rd.

On the whole a very cold month; the temperature almost everywhere below the mean.

M. Buysman.
Middleburg, Holland.

NOTES ON IRRIGATION.—It is sometimes forgotten that irrigation is very ancient. Plato describes in his Critias the Island of Atlantis, which he places to the west of the Straits of Gibraltar. Probably the island was invented by him, and his story is a sort of allegory, but at least his account will show us what one of the best thinkers of the world, at a time 400 years before Christ, considered a model in the way of irrigation. According to him, the irrigation in Atlantis consisted of a circular ditch, surrounding the great plain of the island. It was everywhere 100 feet deep, 600 feet broad, and had a length of nearly 1200 miles. Into it passed straight canals 100 feet wide and 12 miles apart, connected frequently by cross-ditches. The canals and great ditch were also to be used for navigation. The inhabitants had two harvests a year, in winter from rains, in summer from irrigation.

It is now generally recognized that the soil of the dry western states and territories is very fertile when water can be brought on it. In Arizona most of the farming lands are confined to the bottom lands of the principal rivers, but there are millions of acres among the hills and on the plains which could be made very productive if there were sufficient water for irrigation. Much of the land not easibly irrigable is now being reclaimed by carrying on extensive works. In the Salt River Valley an immense canal is being constructed which will convey water enough, it is claimed, to reclaim at least 100,000 acres, besides furnishing water-power for an immense amount of machinery. With 35,000 acres already under cultivation in the valley, the additions made by this canal will make it as completely cultivable as any valley of its size elsewhere. The canal was to have been completed last spring.

In New Mexico and Colorado agriculture is also dependent on irrigation. The rainfall of itself is not generally sufficient to bring a crop to maturity. In New Mexico irrigation has been used on the same fields for more than 200 years with no other fertilizer than that brought down with the water from the mountains, and they are not yet wearing out. Irrigation costs about $1.25 per acre, but farming is much more certain with it, and other fertilizers are not needed. The appearance of irrigated farms is odd. There is an almost total absence of green sward and the watering ditches—acequias—cut up the land so thoroughly

in all directions that one must look to his path or he is liable at any moment to step into one. Acequias go wandering over the uncultivated country and one frequently crosses them without being able to see where they come from or where they go to. The laying out of new ones is an expensive matter and requires the help of competent surveyors. A curious illusion is frequently noticeable among the acequias. They are made as nearly level as possible, but must have a little fall; but as one approaches them he would frequently be willing to swear that, to all appearances, they were running up hill. This illusion is particularly vivid when one approaches them from down-hill.

The following table will give an idea of the extent of these artificial courses. Their total cost is, of course, enormous. The table gives them for Colorado only, but, in addition to that, New Mexico, Arizona, Utah, Montana, Nevada, and parts of the other states and territories depend on irrigation.

Name.	Will Irrigate acres.	Miles Completed.
Grand River, Douglas county	65,000	30
Uncompahgre	75,000	25
The Larimer & Weld	36,000	45
Citizen's Ditch	100,000	45
Pawnee Ditch	40,000	25
Loveland & Greely	22,300	31
North Poudre	40,000	not com
Platte Valley	20,200	28
Fort Morgan	24,000	26
High Line	59,250	83
Del Norte	50,000	29
State Line, No. 2	50,000	29
Total	581,750	396

The High Line canal is quite a river, having a capacity of 8,887 gallons per second. It passes through a tunnel 700 feet long, 20 feet wide and 10 feet high, and is built throughout very solidly, at great expense. The basis of calculation for the number of acres irrigable is a cubic foot of water per second.

To give an idea of the value of irrigation to the farmer, we

take the following from a Galveston paper, from which also the above table has been taken. In Colorado the yield of cereals in bushels to the acre, for the last twenty years, has been as follows. They are given to the nearest bushel. In the first column is the yield for Colorado, in the second for the United States generally.

Indian Corn	20	..
Wheat	22	13
Oats	26	25
Barley	26	22
Rye	15	11

The yield is in every case greater in Colorado and is especially great for wheat, when the increase is 70 per cent.

Irrigation is extensively used in Mexico, especially in the Northern States, where the climate is very similar to the adjoining territories of the United States. They make, however, a much greater use of artificial lakes and reservoirs. From Guadalupe to the City of Mexico one can see from the railroad many such lakes and ponds used for irrigation in the dry seasons as well as for watering stock and supplying towns. Similar reservoirs are common on the plains between Encarnacion and San Luis Potosi. They are of immense size, and large, fine orchards are kept up by their seepage alone.

An important possible source of water for irrigation exists in artesian wells. This has not been overlooked by settlers, but as an artesian well requires some capital and its possible failure some philosophy, this method of getting water has not been tried as often as it should have been. It is a matter of importance for the dry territories and in the vicinity of lost rivers there is every reason to think that such wells need not be deep. It is quite likely that they would not be flowing wells but a windmill would easily do the work of elevating the water.

Artesian wells have attracted most attention in Arizona, and here their success has been gratifying. The legislature in 1875 offered a reward of $3,000 to the person first finding a flowing stream of water by a genuine artesian well. This reward was claimed in 1883 by W. J. Sanderson, of Sulphur Springs Valley, whose deepest well was only 83 feet. He got abundant water, and, as the source was under a bed of clay 20 to 40 feet thick,

the wells were decided to be properly artesian, and the reward given to him. There are now a good many successful wells in the territory, all due to private enterprise, and the governor now appeals to the general government to help them. There is every reason to believe that by proper attention to every promising site for an artesian well large parts of our arid west could be made of extraordinary fertility, and the desert literally be caused to blossom as a rose. It is a proper enterprise for a great government to undertake. In any case it would be infinitely less expensive than a war, while the enhanced value of the public lands might reduce the expense to nothing.

THE ARAGO-DAVY ACTINOMETER.

This apparatus is composed of two thermometers in vacuo, the one the ordinary solar thermometer, and the other a bright-bulb thermometer, and both exposed in the same manner to the solar rays. It was first devised by Arago, but it seems to have been laid aside by him without being brought into use and to have been lost to sight, until resuscitated by M. Marié-Davy, the director of the Observatory of Montsouris, and reconstructed and improved by him. In this actinometer, as generally used, it is assumed that the difference between the readings of the two thermometers, when exposed to solar radiation, is a relative measure of the intensity of that radiation, just as, in the case of the solar thermometer, the difference between the temperature of the black-bulb thermometer and that of the air is so assumed. The former is the more convenient arrangement, since both thermometers can be exposed side by side with exactly the same surroundings, and the thermometers can both be read at very nearly the same instant of time, and this can be done regularly at short intervals of time, if desirable, during any part or the whole of the day. The indications are also more reliable than those of the black-bulb in vacuo alone, since the uncertainty in the case of the latter in the accuracy of the assumption that the temperature of the glass inclosure and of the air is the same, does not enter into the former. In fact the principal advantage in this arrangement over that of the black-bulb thermometer alone, is that the temperature of the bright-bulb

thermometer can be used instead of the air temperature. When not exposed to solar radiation, the two thermometers, where no corrections are needed, indicate the same temperature, which is generally a little below the air temperature, at least in clear weather, but this is a matter of no consequence here, since the differences merely are used.

The instrument is extremely sensitive, indicating very small intensities of solar radiation as well as very slight changes. It is interesting to expose to the rising sun, on a clear morning, the two thermometers, which, before such exposure, indicate precisely the same temperature, and to see how, with the first straggling rays, the absolute readings and the differences of the two thermometers begin to increase gradually and regularly, and continue to do so as the sun mounts up above the horizon; and in the evening again, as the sun descends toward the horizon, to observe the difference between the readings become gradually less and finally vanish with the last rays of the setting sun.

Of course this instrument, as the solar thermometer, measures the rate with which the heat of both the direct and diffused solar rays is received, and so, of the whole heat coming both directly and indirectly from the sun to the earth's surface at the point of observation. If, therefore, the sun shines through a clear space, but in other parts of the sky there are clouds which reflect heat back more than the closer spaces, the intensity is then increased at the place of observation; but in the average over all parts of the earth's surface, the effect of clouds, of course, is to diminish the amount of heat received in a given time. In making observations with this instrument during the middle part of the day, when the differences in the readings of the two thermometers remain sensibly constant for some time under the same conditions, although the absolute readings may continue to increase until late in the afternoon, upon the sudden appearance of cumulus clouds in the surrounding parts of the sky, so as to not interfere with the direct solar rays, the difference between the readings of the two thermometers is at once sensibly increased, indicating an increase in the rate with which solar heat is being received in consequence of reflections from the clouds.

It may be interesting and important to inquire, in connection

with this subject, why the indications of the two thermometers, similarly exposed to the same intensity of solar radiation, are so different; especially as this is a matter which seems, as yet, to be but little understood. In such an inquiry it is necessary to understand the fundamental condition which determines the static temperature of a body, which is, that its temperature with relation to its surroundings must be such that its rate of cooling, when it is not receiving any solar heat, is exactly equal to the rate with which it absorbs the heat received directly and indirectly from the sun. Only the heat absorbed must be considered in the condition determining the temperature of the body, since neither reflected heat, nor transmitted heat in the case of a diathermanous body, has any effect upon the temperature of the body.

All athermanous bodies of the same shape and similarly exposed in vacuo to solar radiation, whether blackened bulbs or silvered bulbs of thermometers, or bodies of any other kind, stand at the same temperature, by virtue of the generally recognized principle that the absorbing and radiating powers of such bodies are equal. By this is meant that if a body absorbs one-half or one-third of the heat falling upon it, and consequently one-half or one-third of what a lamp-black surface would absorb, which is supposed to absorb all, then the same body radiates the one-half or one-third of what a lamp-black surface would at the same temperature, and so for other proportions. This principle we know to be strictly true when the radiating body has the same temperature as the absorbing body, else the temperatures of bodies would not settle down to those of their surroundings, as, for instance, in the case of a body within a tight inclosure the temperature of the body and the inclosure might be different, which is never observed. In the case, however, of a great difference of temperature, such as exists between terrestrial bodies and the sun, we cannot infer from this that a body absorbs the same proportion of the sun's heat which it does of the heat radiated by bodies of its own temperature; in fact, observation seems to indicate that there is a slight difference in the case of some of the metals at least. Granting that the principle is strictly true in all cases, then if a body radiates only half as much as a similar body with a lamp-black surface, it likewise absorbs only half of the heat received from the sun or any other

source, and consequently it has to stand at a temperature just as much above that of its surroundings, as a body of maximum radiating power, that is, a body with a lamp-black surface, in order that the rate of cooling, or losing heat by radiation, may be the same as the rate of absorption. The same is true, however small the absorbing and radiating power, as in the case of a silvered thermometer bulb. The sizes of the bodies, where the shapes are the same, and they are similarly exposed to the heat radiation of a distant body, do not enter into the conditions, since the sectional area which intercepts the rays and the radiating surface have the same ratio to each other for all sizes, and hence the same ratio between radiation and absorption is maintained. As, for instance, in the case of a spherical bulb of a thermometer, if the diameter is doubled, the sectional area intercepting the solar or other parallel rays, which is the area of a great circle, is doubled, and so, also, the radiating surface of the bulb, but there is still the same relation between absorption and radiation.

With diathermanous bodies the case is different. In these the radiating power, since it is the complement of the reflecting power, is equal to the absorbing and transmitting power combined, and consequently the radiating power is greater than the absorbing power. The latter, of course, depends upon the space through which the rays have to pass, and consequently upon the size of the body, or upon the thickness of the plate when the body has this form and the rays fall upon the side. If a diathermanous body and an athermanous body of the same shape are exposed in the same manner in vacuo to the solar rays, it is not necessary for the former to stand at as high a temperature above that of its inclosure as the latter in order that the rate of cooling, when not receiving the sun's rays, may be the same as that with which the sun's heat is received; for this is the case only when the radiating and absorbing powers are the same, but in this case, we have seen, the radiating power is greater than the absorbing, and therefore the body loses heat by radiation as fast as it is received from the sun and absorbed, when standing at a *lower* temperature. For instance, if only half the heat which passes into a diathermanous body is absorbed, then its absorbing power is only half of its radiating power, and the condition of a static temperature is sat-

isfied with a temperature only about one-half as much above that of its inclosure as is required when the radiating and absorbing powers are equal. A small bulb of rock salt exposed in a vacuum to the sun's rays is heated a very little above its inclosure, a bulb of clear glass a little more, and so on; the temperature, in excess of that of the inclosure, being greater as the transmitting power is less, that of a perfectly athermanous body being the greatest of all.

In the case of an ordinary bright-bulb mercurial thermometer we have a heterogeneous body, the mercury being athermanous and the glass diathermanous. On account of the highly penetrating quality of the sun's rays, depending upon the high temperature of the radiating source, the heat passes mostly through the glass to the mercury, but the mercury being a poor absorber, the greater part is reflected back again through the glass, the penetrating quality of the direct ray not being changed much, if any, by reflection. In this case the mercury is the absorber, the small amount of the sun's heat absorbed by the thin stratum of glass being extremely small and the glass is the radiator, the heat absorbed by the mercury being conducted through the glass as fast as radiated from its surface. Putting, therefore, the radiating power of glass at 0.85 and that of mercury at 0.23, the bright-bulb, from what precedes, must stand at a temperature which is above that of its inclosure by an amount which is only about 23-85 of that of a black-bulb above its inclosure, or of any body in which the radiating and absorbing powers are equal. This ratio, however, is always some greater, because the radiating power of a thin plate of glass, such as the stratum surrounding the mercury, is considerably less than 0.85, which is about that of thick glass. The radiating power, therefore, depends very much upon the thickness of the glass and consequently varies considerably in different thermometers. Generally the excess of the temperature of the bright-bulb above that of its inclosure is a little more than one-third of what it is in the case of the black-bulb, which indicates that the radiating power of the thin stratum of glass is a little less than 0.69, or three times that of mercury. On account of the variability of the thickness of the glass in bright-bulb thermometers, and hence of the radiating powers, different bright-bulb thermometers, with the same exposures and surroundings stand often at temperatures considerably different.

Washington, D. C. WILLIAM FERREL.

(To be continued.)

THE AMERICAN NILE.

When we wish illustrations of remarkable things in physical geography we usually look to the Old World, though we have objects quite as interesting in the new. The Amazon, the Mississippi, the Gulf Stream, the Great Lakes, the prairies, and Niagara are so notable that we cannot fail to remember them, but in less striking things we are inclined to forget that we have as remarkable things in our own country as can be found anywhere.

One of the most interesting rivers in the world is the Rio Grande del Norte, but it is almost entirely neglected in our geographies and encyclopedias. Rising in the San Juan mountains in south west Colorado it takes a southeasterly course of 1500 or 1800 miles, to the Gulf of Mexico. Its source is on the Continental Divide in the heart of a group of mountains averaging unusually high, even for the Rockies. Its sources and early course are very picturesque,—surrounded by ragged volcanic rocks,—and are located in the wettest part of the Rockies, being fed by perpetual snows and heavy rains. Its course is first east for 100 miles or more, when it turns south, passing in this direction the entire length of the territory of New Mexico, then turns southeast and continues as the dividing line of Texas and Mexico until it gently flows into the Gulf.

Like the Nile it rises in a region of relatively great dampness, flows through a long extent of desert region, and falls into a great inland sea. Its basin is a remarkably long and narrow one. Its immediate valley in its upper part is extremely narrow, while near its mouth it widens out into great plains. Its sources are in an extensive region of pine forests and it continues in them for about one hundred miles. When it debouches into the great San Luis Valley, in southern Colorado, it enters its desert course and continues this almost to its mouth.

In this entire distance it receives but few tributaries, only two or three of which are of the first order. Sometimes for hundreds of miles it has not a single supplying branch and many of the branches given in the maps are dry for several months of the year. In 1851 the river was dry at El Paso, the water having been drawn off for irrigation.

Like the Nile its volume of water remains nearly the same through almost its entire course. It has few additions but many subtractions. The evaporation over this dry region, and in latitudes near the Tropic of Cancer, is very great. The river bed is sandy and absorbs much of the water. A large part of what remains is carried off by the irrigating ditches, of which there are many from San Luis Valley to the Gulf. Although the river is a long one, it is small and not suitable for navigation. Vessels drawing three or four feet of water may get up to Brownsville. Smaller ones can go as far as the mouth of the Salado without much difficulty. Beyond that they cannot pass except with unusually high water, at which times they sometimes get up to Laredo.

Like the Nile, too, the Rio Grande is subject to periodical floods which are utilized by the residents for fertilizing their lands. This is especially the case on the Mexican side below Comargo. The water is always of a yellow color, like that of the Missouri river. At the time of the floods, slime is deposited over the adjacent lands, giving them an appearance unpleasant to the traveller. This deposit is highly prized by the farmers, as an excellent fertilizer, surpassing that of the Nile.

Like the Nile region, the apparently desert country through which it passes is one of extraordinary fertility if it can be irrigated. The finest crops can be raised throughout its entire length and the desert can easily be made to blossom as the rose. The fruits along the Rio Grande in southern New Mexico are among the finest in the world. The grapes are so abundant that they form no inconsiderable part of the food of the natives for the three months during which they last, and the El Paso wine is cheap and excellent. Cotton of good quality is raised in large quantities about Comargo.

As a result of this fertility and of unusually good sanitary conditions we have, along each river (the Nile and the Rio Grande) signs of the most ancient civilization known on their respective continents. From near its source for fully half its length the Rio Grande has abundant ruins of the pueblo civilization found there by the Spaniards, and of the still earlier cliff-dwellers, concerning whom we have not a particle of either history

or tradition. The evidences are, however, that the highest early American civilization was along the Rio Grande, as the early Egyptian civilization—the highest in Africa—was along the Nile.

The Rio Grande differs from the Nile in some essential particulars. It runs from north to south, hence its overflows would be of longer duration. It runs in part through a region of very great mineral wealth. Its source is close to one of the most remarkable of the silver districts and, along its course from that point to near where it leaves New Mexico, its hills and mountains have been worked from time immemorial for the precious metals. Although surrounded by extensive arid regions, all of it is more accessible than is the Nile, and a notable difference in favor of the Rio Grande is that it is in America and not in Africa. It is a smaller stream than the Nile, belonging with the Columbia, the Danube and the Volga, while the Nile is among the giant rivers.

The overflows of the Rio Grande are not so regular as those of the Nile. Its sources are in a region of high latitude where there are greater annual fluctuations in the weather than near the equator where the Nile heads. The rise in the river is usually only two or three feet, and some years pass without a sufficient rise to overflow the lands. Its floods are due to two causes, the melting of the snows in its upper course, and the spring and early summer rainfalls in the same region. The volume of each flood depends on whether these two causes work together or not. If they do a heavy flood results, if not the flood may be slight or inappreciable. Occasionally several years pass without a marked rising in the river.

As an illustration of an unusual flood, I will give an account of that of 1884:

There had been remarkably heavy snows near the sources of the Rio Grande in the winter of 1883–4. At a little Mexican town called San Antonito, fifteen miles southwest of the railway station Antonito, in the Rio Arriba county, on the Denver and Rio Grande railroad, the snow was 25 feet deep on April 9th, 1884. There was no trace of the town visible: the smoke from the fires seemed to come directly from the pure white snow. There was no sound of life. People entered their houses by snow stairs, and traveled only on snow shoes, crossing over house-tops and the tops

of trees and carrying fire-wood from a great distance. Col. Cummings' residence was in Eureka Gulch. It was 70 feet long, and 25 feet from the ground to the ridge pole; his barn was two stories high; yet not a shingle of these building appeared and a traveler might pass over them without knowing it. This snow-fall was currently considered the most remarkable one ever seen in that country. A great many cattle perished; but, in some way, the heavy snow-fall was generally anticipated and cattle were driven out of the county. The snow improved grazing and placer-mining. It did not extend far east, as Taos County had but little snow, and Santa Fé County still less, but on May 21 it was yet ten or fifteen feet deep in the northern part of Rio Arriba County.

When this great mass of snow melted, it would naturally cause high water in the streams whose waters were derived from that region. This flood was so far advanced on May 13th on the Rio Grande, that travel was partially suspended, and on the 16th, part of the track of the Atchison, Topeka and Santa Fe railroad was washed away. The waters continued very high throughout June and into July. Bridges were carried away the entire length of the stream in New Mexico. The destruction was, if anything, increased by the delusive hope, caused by each frequent fall, that the flood was over. The devastation was very great. Agricultural lands were overflowed and completely ruined by the sand and gravel left behind. Villages were deserted or even swept away. Two thirds of the crop of the entire valley was probably ruined.

But the most remarkable feature of the flood was the light thrown by it on the character of the Rio Grande itself. It is a most treacherous and fickle stream. South of Socorro the channel swept over where the track used to be. A little below Rincon, a work train was let down, by the giving way of the track, into a spot which at once became a part of the river. The entire train sank immediately out of sight and soon after the engine could not be reached by exploring poles ten feet in length. For more than a month the course of the river south of Albuquerque was changed hourly. In some places the change could be measured by hundreds of yards. Tome, Valencia and Peralto were swept away. The track was frequently washed away for miles; then it

would be rebuilt around the gap, only to be encroached upon again. In this way the road bed was in places changed three times. The railroad people down the river strained every nerve to keep communication open and to relieve the destitution of the inhabitants. The Pueblo Indians say that no such volume of water had come down the river before for eighty years. Its long continuance was due to the fact that the snow melted very slowly about the headwaters. In the second week in June the snow was still from two to sixteen feet deep in southern Colorado.

The bed of the Rio Grande is very changeable, and quick sands are common. It is a common saying among the Mexicans that he who falls into the Rio Grande is drowned. This is due, not to the depth of the river, but to the quick-sands which engulf him. The Antelope Valley, only a few miles from the source of the river, has been at every point successively occupied by the river bed. Three old channels can now be detected within its narrow limits and there is evidence that at this point the stream once flowed nearly a thousand feet higher than at present. At Santo Domingo it has within historical times changed its bed at least two miles, and is now threatening a church placed 30 feet above the water. Albuquerque was, 170 years ago, on the west side of the river and is now on the east side. The Alameda grant, six miles below Sandia, was, in the middle of the eighteenth century, on the opposite side of the river from its present position. This fact has been judicially brought out. We mention these facts as illustrations. Similar ones exist the whole length of the river, showing that its bed is remarkably changeable. This feature is even more remarkable on the lower part of the river, where the channel has been known to change twenty miles. It is this fact with the number of constantly changing quick sands, rather than the volume of water, that makes extensive navigation on the Rio Grande improbable.

The climate along the river varies less than would be expected from its range in latitude. The air is almost everywhere dry. Dews fall only toward the mouth of the river, where they are sometimes so heavy as to take the place of showers. The rainfall is slight. The heat of summer is great and the winters may be cold. Ice occasionally forms at El Paso and heavy snow-storms

have been known there. At Isleta, below El Paso, snow is said to have covered the ground when Ottermein arrived, in 1681, with his forces to recapture Santa Fe. It is in the range of the *Northers* and sudden and severe changes are not uncommon. The sand storms are often severe from Albuquerque down. The prevailing winds are westerly and may continue for a week or two. These winds cause a constant shifting of the sands, thus tending to decrease the profits of agriculture, as the sand is liable to drift over cultivated fields. The most dangerous strip is the Medanos which extend with more or less interruption from Chihuahua to the Sandia Mts. About 150 miles south of El Paso they make a strip five or six miles in width which is dangerous to pass at certain dry and windy seasons. A sand hill fifty feet high may change its place under the influence of the wind in a single day.

M. W. Harrington.

ON THE RELATION OF METEOROLOGY TO YELLOW FEVER.

PART III.

What is requisite to increase our efficiency in the study of yellow fever causation from a meteorological stand-point?

In reviewing the climatic features of the great epidemics of yellow fever, as far as our limited data permit, we find it difficult to make out a case in favor of any distinct theory in regard to yellow fever causation.

We find that in 1853 certain conditions did exist—so ably set forth by Dr. Barton—notably an abnormally high barometric pressure. In 1878, during our epidemic, ranking next to 1853 in point of intensity, we find a barometric pressure below the average; and also below the same factor for the next preceding and succeeding year—the same months only considered.

There is some analogy between the relative humidity of the years 1853 and 1878, but not sufficient to enable us to assign this element as the *vera causa* of the disease. In 1853 the highest daily mortality was 244 on August 21st, and 235 on the 22nd. In 1878 the highest daily mortality was about 100. This latter in a population of about 200,000. This was equivalent to an annual

mortality of 182.5. The maximum mortality of 1853 was equivalent to a yearly mortality of 385.5 per 1,000 population. The intensity of the epidemic in 1853 is thus shown to have been more than twice that of 1878, judging from the effect on the destruction of life.

In considering alone the elements of temperature and humidity how are we to determine the status of these elements essential to produce a resulting effect in intensity of the disease? It is self-evident that no such deduction can be made. Passing on to a consideration of the temperature alone, the most thoroughly studied of any meteorological element, we find from the records that in nearly every year in New Orleans the average temperature has been above the standard considered necessary for the growth and propagation of yellow fever, and above the average for 1853, the yellow fever season alone being considered.

The average of twelve years' observation by the U. S. Signal Service gives for July, August and September a higher value for each month than was obtained for the same months in 1853. The average humidity, however, for these months is, for July, 72.9 per cent.; for August, 93.4 per cent.; and for September, 72.4 per cent. For 1853, the monthly averages, as before stated, were, for July, 82.5; for August, 87.3; and for September, 85.7. So that since the same condition obtained in 1878, in a minor degree, we must admit the influence of a certain combination of moisture and temperature in the make-up of the conditions requisite to the fomentation and augmentation of this disease.

But if we depend upon this combination alone we shall find ourselves sadly at fault, because in many years of average healthfulness we have experienced longer and shorter periods of a temperature sufficiently high for yellow fever, and the simultaneous occurrence of a very high dew point.

And yet, any one who has made a study of these matters has recognized the fact that yellow fever requires a climate of a high degree of moisture. The "plague" of the east, on the contrary, never flourishes in a moist climate.

That cholera, again, requires a distinct climature is evident from the fact that these diseases never exist simultaneously at the same place: as witness the history of cholera and yellow fever in

New Orleans during the years 1832, 1849, 1853, and 1873. In the latter year the late Dr. White, in his history of the cholera outbreak of that year, laid much stress upon the existence of very unusual meteorological conditions, in a great and abnormal range of temperature, very sudden and extreme changes, etc. He says in his report, in speaking of the rain-fall, "April and May, meteorologically, seem to have changed places." The cholera commenced in the latter part of February, and increased in intensity, reaching its maximum in May, but in June only nine deaths occurred, and none in July—giving place to yellow fever in the latter month, after the meteorological elements had changed.

Dr. Mulvaney, of the British navy, states that during the prevalence of cholera on board the "Magpie," in 1871:

> "It was not a little remarkable that when the heat reached its maximum, *and brought in its train great humidity and arid stagnation, the cholera entirely ceased;* but reappeared as soon as the great heat was over, and the morning and evening atmospheric circulation became again brisk."

I have italicized the above sentence because it is especially pertinent to this subject of a special meteorological condition governing special diseases.

But, while we recognize a certain indefinite relation of climate to special diseases, we cannot, by the instruments, at present employed, define any definite relation. We cannot say that with a certain barometric pressure a certain degree of temperature or percentage of humidity, a certain disease or a specific intensity of any disease will follow as a sequence. It is painfully evident that we are deficient in our data.

It is evident that there is something we have not arrived at; some facts are missing in our problem.

Much stress has been laid upon certain atmospheric influences during the presence of, and prior to, the greater epidemics, often called the "yellow fever influence," of which our instruments give us no indication. This was especially noted in 1853, and has been referred to on a preceding page; and in 1878, Dr. White, a very close observer and student of atmospheric phenomena, early in the season of that year, stated his conviction that an epidemic of yellow fever would prevail largely in the south-western

states. And not only in this country, but in South America has this indefinable something, manifest to our senses, been observed and commented upon. In reference to this subject Dr. Barton pertinently says:

"These are more obvious by our feelings than by our instruments, and the day is not distant when these can be stated more precisely."

The purifying effect of thunder storms upon the atmosphere seems to be an unsettled question. In speaking upon this subject Dr. Barton says:

"Storms of thunder and lightning I have noticed for thirty years in this country, to exist during epidemics, and instead of 'purifying the atmosphere,' to injure the sick; they existed throughout the epidemic here and elsewhere last year (1853). They have been noticed during epidemics at Rio and Demarara and other places. It is the opinion of many physicians in tropical climates that this development of electricity increases the number of cases of yellow fever; that in proportion to the violence of the storms, the disease augments in violence, and that it aggravates existing cases."

But should we, finding our present methods insufficient, abandon the study of these important relations? Not only should we not relax our vigilance, but we should push our investigations into new fields, continuing our present instruments, as being in no sense unimportant, but as factors in a problem, at some of whose elements we have not yet arrived.

We need a more systematic method of observation and record than we have had in the past. Matters that are apparently unimportant should be recorded and collated in a compact form for easy reference and comparison.

The destructive effect of the atmosphere upon animals and plants, mentioned by Dr. Barton in 1853, and referred to on a previous page, and observed during severe epidemics, is of itself a matter of importance, as showing that some specific condition existed of which we can have no conception at present.

Happily we have secured through the U. S. Signal Service a thorough and systematic method of observation and record applied to the whole country, furnishing a uniform system. But there is a very great need of independent observers who have the time, the patience, and love of investigation combined, to con-

duct special investigations in lines of inquiry not coming within the scope of the work of U. S. Signal Service.

It is very much to be regretted that no systematic tests for ozone have been made during the existence of yellow fever epidemics. Dr. Barton suggested that it was probable that no ozone existed, or a very small quantity at least, during the epidemic season of 1853, and, from my own limited observation, I should judge this to have been the case in an atmosphere such as he described. As the artificial production of ozone is within our possibilities, the importance of this branch of inquiry is apparent.

The State Board of Health is now conducting tests in this city and state, which in time will afford data for a study of this powerful atmospheric agent, in its relation to yellow fever and other diseases.

The element of solar and terrestrial radiation is one that should be studied as presenting anomalies as yet but little understood in this latitude. Since the death of Dr. Barton this subject has not received any attention here, to my knowledge, except during the four years 1872 to 1875, under the supervision of the Board of Health during that period.

But transcending all other elements, in my judgment, as a meteorological inquiry, no less than in the question under discussion, is the subject of atmospheric electricity.

The question of electrical manifestations in the form of thunder storms, and the general relation of electricity to the animal economy, has been the subject of theory and speculation during a century or more; but owing to the lack of suitable instruments, for the observation of this phenomenon, as well as general indisposition to undertake an investigation requiring long and diligent labor before any definite results can be arrived at, this has not yet received much practical attention, within the yellow fever zone especially. Observation has so far been confined to a study of the effects of thunder storms upon the intensity of yellow fever, which is about as effectual as would be the study of barometric pressure by means of the effect upon our senses of the elasticity of the atmosphere.

As affording a reference to the many and varied theories ad-

vanced by men eminent in thought, I quote from the distinguished La Roche:

"If while recollecting the almost universal agency of electricity over the laws of inorganic matter, we take into consideration the diffusion of the fluids in the atmosphere, both in its tranquil and disturbed states; if we bear in mind the close analogy or correlation existing between it and the cause presiding over certain phenomena of innervation; * * * if besides, we consider that the nervous system derives from the atmosphere a portion, at least, of the electrical properties requisite for the performance of its functions, and if, with these facts before us, we recollect that electricity is elicited in the process of the living economy—increased under peculiar circumstances,—and modified by cold, lassitude or sudden motion, we shall discover, in the absence of other and more positive proofs, a strong argument in favor of the conclusion, that from its excess or paucity will result certain modifications, for good or for evil, in the play of the functions.

"We may conclude too, that from the same influences will result various changes in the atmosphere and in the chemical combinations of surrounding objects, calculated to impart to these deleterious properties, or to aid in the diffusion of morbific causes. * * * So evident indeed are the effects mentioned and their connection with electrical states of the atmosphere, that, while unwilling to believe with Foster, that it is not the heat, nor cold, nor dampness, nor draughts of air, which are chiefly concerned in producing disorders, nor the sudden transition from one to another of these conditions, but some *inexplicable peculiarity* in the electric state, we cannot but admit that in the instances referred to, and others of the same kind, the effects must be sought in the influences assigned, and not, as has been done, in the hygrometric changes which accompany alterations of weather; though these, as well as barometrical and thermometrical variations, contribute to the result."

In reference to this subject I quote also from Doctor Parkes, as showing that later philosophy has not abandoned the question of these relations of electricity to meteorology and physiology:

"That these (electricity and light) as well as heat, are important parts of that complex agency we call climate, seems clear; but little can be said on this point. In hot countries *positive electricity is more abundant;* but the effects of its amount and variation on health, and in the spread and intensity of diseases is quite unknown. All that has been ascribed to it is pure speculation. The only certain fact seems to be that the spread of cholera is not influenced by it."

Doctor Lallemant, of Rio, as far back as 1850, in discussing the question of yellow fever causation, said:

"We cannot deny the greatest analogy, or at least, a most indubitable relation between electro-galvanic or magnetic action and the process of human life: the first being diminished, the second necessarily becomes deteriorated; and when the reaction from a part of the earth's surface against its atmosphere becomes latent, the process of zootic life ceases. * * * That magnetic needle, the *biometer*, which we may apply to our bodies, to observe the most delicate perturbations—the internal disturbances of our vital forces, inappreciable to our grosser senses—is still wanting to us; and while the astronomer makes the almost divine discovery of a new planet not yet visible, by calculating the perturbances of another about the sun, the physician, although he has the stethoscope to aid his hearing, and the microscope his sight, is condemned to examine the vomiting, the urine, and the dejections of individuals, in order to form some proximate judgment, which is often quite erroneous with respect to the vital forces of man."

The limited observations so far made upon atmospheric electricity serve as our index to the very great annual variations in the quantity, tension, or whatever property, of this mysterious agent which affects our instruments employed for its detection—variations which we do not meet with in any other of the atmospheric elements which we have investigated. Dr. Turley found from four years' observation that the units of measurement employed by him were more than thirteen times greater in amount for September and January, than in the months of June and July. I do not know what were his methods, or where his investigations were made, but it is presumed that his instrument was of a primitive pattern. Later on we have the record of Prof. Denza at Moncalieri, at the base of the Alps, referred to in the report of the Smithsonian Institution for 1881. These observations extended over a period of twelve consecutive years from 1867 to 1878, wherein, employing a different system of units, he shows the monthly averages do not vary to so great an extent, but finds the potential, expressed in arbitrary units, about fifty per cent. greater in winter than in summer; and what is more interesting, he finds that during some years, the potential is about four times greater than during other years, and that this singular anomaly is not a gradual rise and fall, but it occurs sometimes in alternate years,—a year of low potential being followed by one of very high potential. May we not find here an explanation of the phenomenon of epidemic years alternating with those especially healthful?

These electrical observations cannot be applied to localities foreign to where they are made, but must be studied "upon the ground," as enough is known to satisfy us that very great differences exist in different latitudes and localities, in the amount, or intensity, of electrical forces. The known law of magnetism, —that it increases in intensity from the equator to the poles— is an indication, worthy of consideration, that the electricity of the atmosphere is correspondingly augmented in intensity or other condition as we recede from the equator. It may yet be found that this disease of the tropics,—yellow fever,—is due, not so much to the temperature of that zone, as to some specific electrical condition of the atmosphere.

In conclusion we find that we require more light—an increase of laborers in the field of investigation; and a more extensive and systematic collection of data. Nature will not give up her secrets without the expenditure of long and patient industry. It required the life labors of a great master and a greater pupil to formulate the system of planetary movements upon which the science of astronomy is based; and from the labors of those who make a conscientious and careful study of her varied and complex phenomena, seeking only *Truth*, some Keppler of the future will evolve *Meteorological Law*.

I. H. STATHEM.
NEW ORLEANS, LA.

LITERARY NOTES.

(153) **P. G. Tait.** *Properties of Matter*, Edinburgh, Adam and Charles Black, 1885, 8vo, 320 pp. Professor Tait's personality crops out strongly in every thing he writes. This is right and, besides giving the author a chance to speak with freedom, adds interest to the book, for all are more interested in a man in the concrete than in the abstract. Throughout this book, the author rides some of his special ideas on every opportunity. For instance he insists on the fact that energy is a thing, while consciousness or volition are not. Of course it depends altogether on the definition we give to "thing." In this case the discussion is the more ingenuous and charming as the author, himself indulging in the above touch of metaphysics, attacks the metaphysicians with vigor, making, for instance, a clear distinction between what is metaphysical and what is true.

Newton occupies an unique position in the eyes of the world. He is

generally considered one of the most prominent figures in the revival of science. To two classes he is, however, something different. To the paradoxer he is the especial object of attack. There have probably been more complete overthrows and absolute refutations (in the opinion of the authors) of Newton than of anybody else, and, to many of this class, the contemplation of Newton's position in the opinion of men is gall and wormwood. To the second class belongs a smaller number who look on Newton as *the* great man of the ages, almost inspired, and who add commentaries to his words in the spirit of a commentator of the scriptures. To this class Professor Tait seems to belong, and it has often seemed to the present writer when reading something from his pen, that Newton must often have "builded better than he knew."

The book is intended as an introduction to a course on physics. It is remarkably interesting and has the freshness of something hot from the brain of an eminent physical authority. Old facts wear a new dress, and facts new to the users of text-books are abundant. This feature makes it of interest to private students and readers generally. In fact the book, really intended for students in the lecture-room is probably better adapted to the private reader. For teaching purposes the treatment is unequal and the perspective imperfect. Many things are treated in grea detail, others neglected. For instance in elasticity the treatment of isotropic bodies is elaborate, that of non-isotropic is professedly absent. For well-rounded information to the student who depends mainly on the lectures, a sketch of the entire subject should be given, while for the reader who consults many authors, the treatment here is particularly satisfactory. The long quotations from Boyle, Kant, Newton and Clerk-Maxwell, are eminently satisfactory for the private student, not so much so for the class-room.

The meteorologist is a physicist, in a certain limited direction to be sure, but still a physicist. The more physics he knows, the better able he is to have an independent judgment on the more recondite questions of meteorology. It is desirable that he be as familiar with all physics as possible and we commend this book to him as an excellent one to read and to keep on his shelves for reference. Among the discussions of more direct interest to him will be that of graphical representation, especially contour-lines, including isobars and isotherms.

The author thinks that the particles which have caused the recent twilight phenomena must average about $\frac{1}{12000}$ of an inch in diameter. The length of time they have remained suspended is accounted for by the principal found by Stokes, depending on the viscosity of the air. A droplet $\frac{1}{10000}$ of an inch in diameter falls at the rate of an inch and a half per second only; if it is $\frac{1}{100000}$ of an inch in diameter, its fall will be only $\frac{1}{100}$ of that, or not more than one inch per minute. The author gives his full adhesion to Aitken's deduction that condensation commences in free

air only in the presence of dust-particles; that is, each droplet of a cloud has a dust-nucleus. If true, (and it seems to be so) this fact introduces an element into the subject of precipitation, which has not yet been taken into account by meteorologists. Condensation of water takes place more freely the less convex the surface on which it takes place; hence the growth of large drops of rain at the expense of small.

Of considerable interest in the theory of thermometers is the discussion which terminates on p. 154, from which appears the paradoxical result, that "the interior layers of a glass tube, exposed to external pressure only, are always extended in a radial direction. This extension is greatest at the interior surface, and vanishes at a layer whose radius is about 1.6 a (when a is the internal radius). If the external radius be greater than this, the outer layers are radially compressed, and the more the farther they lie beyond the limit of no extension."

But the book is full of suggestions and space forbids further quotation. The reader who wishes to follow it farther must refer to the book itself.

H.

CIEL ET TERRE. Nos. 11 and 12 Aug. 1st and 15th, 1885, pp. 241–288.

(154) **Accroissment du nombre des coups de foudre en Saxe,** *pp.* 51–56. (D'après les Abhandlungen der naturf. Gesellschaft. Isis 1884, p. 95, et Gaea 1885, p. 215).

In Saxony, according to the investigations of M. Freyberg, the frequency with which terrestrial objects are struck by lightning has increased in a remarkable degree during the last forty years. From 1841 to 1870 about 2140 cases were recorded, being at the rate of 72 per year; while during the period from 1871 to 1882 there were no less than 1826 instances in which lightning was known to strike,—being at the rate of 152 per year, or an increase of more than a hundred per cent. In the larger cities where the roofing material is usually of tile or slate, only 13 per cent. of all known cases result in fire, while in the villages and country, where the roofing material is largely of wood, 39 percent of all the cases in which a building is struck by lightning result in fires. For the neighboring states, where a similar increase in the frequency of lightning has been observed, M. W. Holtz finds that there has not been a corresponding increase in the number of storms. The greater probability of an object being struck by lightning cannot be attributed to an increase in the number of buildings, but is believed to be due to the extension of the network of railway, telegraph and telephone lines, and to the large amount of metal now used in the construction of buildings. The hope is expressed that the number of lightning conductors, made according to rational principles, will be multiplied, so that the prejudice with which these truly useful safeguards are viewed may be wholly overcome by an examination of the results obtained.

(155) **J. Vincent.** *Les trajectoires des minima barométriques* (pp. 261-274) In this paper the fundamental principles of Modern Meteorology are first briefly reviewed and illustrated by means of two plates of diagrams.

For investigating the causes which seem to determine the laws of motion of barometric minima the author makes use of the results obtained by Köppen and Van Bebber who have found that the "lows" which cross Europe usually follow certain paths, depending upon the season of the year. Five principal paths are laid down on the accompanying plate.

Track I passes in a northeasterly direction, off the north coast of Scotland, until it strikes the northern coast of Norway where it subdivides into three separate paths, one continuing in the original direction, the second going directly east and the third a little to the south of east. Track II goes directly east, crossing the southern portion of the Scandanavian peninsula and central Russia. Track III passes through Denmark in a southeasterly direction into Russia. Track IV, in a northeasterly direction through England, Denmark, and Russia. Track V goes through France in a southeasterly course until it strikes northern Italy, where a subdivision into three branches takes place, one continuing in the original direction, a second going directly east, while the third passes northward along the eastern coast of the Baltic. The routes most frequently followed are I and IV. The former being followed with a maximum frequency in autumn and winter and a minimum in the spring, while for the latter the maximum is reached in the summer and autumn and the minimum in the winter.

In 1872 Clément Ley showed that the direction of motion of a "low' was determined by the general distribution of the surrounding temperature and pressure, and the two laws depending upon these two elements are familiar to all meteorologists. In an illustrative example of a typical cyclone it is shown that the resulting direction of motion of the "low," as determined by these two laws, is the same as what the writer calls the dominant motion of the wind; and that, although this dominant direction does not always coincide with the direction of the "low," it does not follow that this law must be condemned, since this would presuppose that the temperature decreases regularly with the height, which is far from always being the case.

The writer concludes his remarks with the very sensible suggestion that the work which should occupy the first place in meteorological investigations should be the study of data obtained with the aid of captive balloons. Such data are almost wholly wanting at the present time. S.

Societa Meteorologica Italiana. *Bollettino mensuale*, pubblicato per Cura dell' Osservatorio Centrale del Real Collegio Carlo Alberto in Moncalieri. Series 2, vol. v, Nos. 2-5, February to May, 1885, 4to, pp. 17-80, Turin.

(156) **P. D. Timoteo Bertelli.** *Riposta ad Alcune obbiezione ripetute contro le*

Osservazioni microsismiche, etc., 17-19, 33-38. To Professor Bertelli is due the earliest systematic observations of the change of vertical as shown by the changes of position of a pendulum. His observations were begun nearly fifteen years ago and have been continued up to the present, making a total number of about 50,000. The observations have since been taken up by others, notably by Abbadie in Africa, Plantamour and his successors at Geneva, a knot of English scientists, especially Professor Darwin, who applied new and striking methods; but the origin of these observations and the persistent fixing of the attention of the scientific public on them is due to Professor Bertelli. In the memoir, whose title is given above, and which runs through four numbers of the *Bollettino*, the author defends his methods from the attacks made on them after the earthquake of Ischia in 1883, and restates, in succinct form, his results and the character of the literature on the subject.

The observations are called by the author "tromometric," and the motions of the earth's crust traced by a "tromometer" (that is a pendulum which leaves a magnified tracing of its swing), have no necessary connection with the minute vibratory motions called microseismic. They are also independent of vibrations due to storms, except, perhaps, those due to the striking of large waves on a beach not too distant. They are not affected by winds or changes of temperature. Large magnetic perturbations are sometimes accompanied by tromometric motions.

On the other hand the tromometric motions do have notable coincidence with barometric changes, especially when these are sudden, though they may be so little noteworthy as to escape general attention. They are also in relation with the eruptions of the Italian volcanoes, as has been especially proven for Ætna. This the author considers as due to subterranean gas-channels. As to earthquake motions, the tromometric observations usually coincide with them, but do not precede in such a way as to afford opportunity for prediction. The memoir is accompanied by graphic representations, from which it is easy to deduce a maximum in winter and a minimum in summer. The influence of the positions of the sun and moon is unmistakable, and the tromometric observations thus take a tidal character.

Space forbids our following further this very interesting discussion. For the form of the graphic representations and the character of the literature on the subject, the reader who is sufficiently interested must turn to the memoir itself.

(157) **Giuseppe Roberto.** *Brevi Note per alcune Trombe*, pp. 19-21. Professor Roberto thinks that a cyclonic area with axis oblique to the ground. Such cyclones, he conceives, would by the friction of the lower part on the ground, be naturally resolved into two, one with horizontal axis (a *temporale*) the other with vertical axis (a *tromba* or tornado.) He reviews

three of the later tornadoes in Italy and Austria, and finds in them the required support of his theory.

(158) **Domenico Ragona.** *Sul Calore delle Irradiazioni Solari*, pp. 49-51. Professor Ragona, Director of the Royal Observatory at Modena, has been studying air temperatures due to direct solar radiation by an apparatus of simple but novel character. It is a thermometer on a bed of swan's down, with subsidiary apparatus which aids in fixing the instrument across the sun's rays and timing the duration of exposure. Alternate observations are taken in the sun and shade.

(159) **Giovanni Mariacher.** *Note fenologiche ad un Quadriennio d'Osservazione*, 1880-1883, pp. 52-53. Professor Mariacher here gives his results for four years of phenological observations, and gives tables for the four principal phases of development (leaf, flower, fruit and fall of leaf) for the common perennials. The observations were taken at the station of which he is director (Cavazuccherina, near Vicenza.) The following general results may be of interest:

Germination and foliation take place at temperatures between 5° and 20° C.

Flowering, between 10° and 25° C.

Maturation of fruit, between 15° and 30° C.

As to the part which thermic accumulation (so interesting to phenologists of a generation ago) may play, the author thinks previous theories have been defective, and proposes that the accumulation be hereafter obtained from the equation.

$$q = t\,g\,h, \text{ or } g = \frac{q}{th}$$

when q = the quantity of heat, t = the thermal mean on the relative vegetative scale, g = the number of days, and h = the hours of daylight. He proposes that the thermal mean be obtained from maximum and minimum observations of the soil and of the air.

It is interesting to find an attempt at scientific treatment of this important part of meteorology which it is now the custom to leave entirely to inexperienced amateurs. Previous methods have been so unscientific that the results to be obtained would not justify the labor and time required for the phenological observations. When the methods are sufficiently improved the necessary observations can be easily obtained.

(160) **Federico Cafeiro.** *Bufera in Messina*, p. 52. A notice of a severe storm at Messina on March 19.

(161) **Domenico Ragona.** *Studi sulla Frequenza dei Venti e sulle Relazioni della Medesima coi principali Elementi Meteorologici*, pp. 65-67. This is a part of the memoir of Professor Ragona, to which a prize was awarded, as already mentioned in the Current Notes. The discussion is of the interior valley of the river Po. In this extract the annual and diurnal frequency of winds are alone discussed.

(162) **Guiseppe Roberto.** *Sul Significato di Unita Magnectica, e dei Numeri che rappresentino l'Intensita del Magnetismo terrestre*, pp. 67-70. A simple explanation, ingenious as well, of the objective meaning of magnetic force when expressed in scientific units.

The remainder of the number of the *Bollettino* is made up of notes on meteors, earthquakes, storms and other notable phenomena, of the reviews of current meteorological publications, and of a review of the weather for the month. In the same covers are included the monthly reports of observations at Moncalieri. H.

DAS WETTER No. 8, 1885.

(163) **Ergebnisse zehnjähriger Gewitterbeobachtungen in den Fürstlich Lippeschen Forsten.**, pp. 141-147. The tabular arrangement of the results obtained from ten years observations of thunder-storms in these forests is designed to show the frequency of the storms, the direction of motion, and the accompanying phenomena, for the different months of the year, and for different times during the day. Thunder-storms occur most frequently in July, and a majority of all the storms recorded were observed between midday and six in the afternoon. Particular attention is given to the name, condition, and part of any tree which is struck by lightning, and also to the direction taken by the electric fluid. On an average nine-tenths of all the trees struck were in a healthy condition, the remaining ones were in a diseased state. As no figures are given, showing the ratio of the number of diseased trees to the total number of trees, it is impossible to learn whether a given healthy tree is more apt to be struck than a diseased one. The tendency of lightning to strike in oak trees is plainly evident. Of the total area covered by the forests, about one-tenth contains oak trees, yet the number of times the oak was struck is greater than that of all the other trees—which were struck—combined.

(164) **Meteorologische Notizen und Correspondenzen.** On June 23 a magnificent twilight phenomenon was first seen at various points in Germany. The evening sky presented the same singular appearance for several weeks subsequent to this date. Shortly after sunset the celestial vault would become overcast with fine white streaks of light, very much resembling cirrus clouds. The long duration of the phenomenon after sunset seems to render it very probable that it is caused by matter in a very finely divided state situated in the upper regions of our atmosphere. The real cirrus clouds, visible at the same time, assumed a dark appearance having this fine white light for a background. S.

(165) BOLETIN DEL MINISTERIO DEL FOMENTO DE LA REPUBLICA MEXICANA Mexico, Folio, tri-weekly. Nos. 85-89, Sept. 26—Oct. 10, 1885.

These numbers contain the usual hourly observations at the City of Mexico; also the resumes for March for Hacienda del Pabellon in Agnas-

calientes, and Colegio Civil in Querètaro. A large separate sheet gives the general and comparative results of observations since 1877 at State College of Puebla.

(166) **S. P. Langley.** *On the Temperature of the Surface of the Moon.* Reprints from National Academy of Sciences. Read Oct. 17, 1884, 4to, separately paged, 32 pp. and 5 plates. Professor Langley's work is a good illustration of the proper and diligent use of a new and efficient instrument. By means of his bolometer he is traversing new fields, adding to, changing, and correcting our knowledge. In this last paper he has given the results of his studies of lunar temperature. The studies have extended over several years and give the following results: it seems that the moon's surface, when illuminated, is at about the temperature of freezing. The sun's heat is reflected in nearly the proportion to be expected from a surface of the rough character we know it to have. Abundant heat is received from the moon, therefore; but to the question, how much of this is radiated from the moon itself? the answer is not so easy. Later observations show an unmistakable lunar heat-spectrum and bring out, moreover, the remarkable facts, that we seem to get from the moon lower wave-lengths than from the sun, and that the earth's atmosphere is more diathermanous for the lower wave-lengths than had been thought. H.

(167) **Ueber den täglichen und jährlichen Gang sowie über die Störungsperioden der magnetischen Declination zu Wien.** Von J. Liznar.

[*In Sitzungberichte der kais. Akad. der Wissenschaften.* Band 91, II Abth. März-Heft 1885.]

A magnetograph of the Kew pattern was put in operation by the Austrian meteorological office in 1874 and has been maintained in operation ever since, yielding a ten year record a portion of which—the declination record—has been studied by Mr. J. Liznar, and the results published in the pamphlet before us. Of the ten years' record Mr. Liznar rejects the first three on account of the numerous breaks in the record due to failures in the photographic process, especially in the summer months, and from the remaining seven years' records deduces:

1st. The daily range;

2d. The yearly range;

3d. The daily and yearly disturbance period;

4th. The solar rotation disturbance period and hence the solar rotation period itself.

The subject of the daily range of declination at Vienna had already been studied by our author from observations at four hour intervals 1852–1871. From this new study of more complete material certain views in the earlier publication have been modified. The observations on which the

present conclusions rest are the continuous photographic records for the seven years, 1878–1884.

During the summer months two well defined elongations, in the daily swing of the magnet, or a maximum and a minimum occur, the morning one between 7 and 7½ A. M. and the afternoon one about 1½ P. M. In the winter months the elongation hours are near together, the morning one later, about 8½ A. M. and the afternoon one slightly earlier, about 1¼ to 1½ P. M. There also appears in the winter months two other small secondary elongations at about 4½ A. M. and at 10½ P. M.

As usual the amplitude of swing is greatest in summer and least in winter ranging from 9½′ to 3½′.

It further appears that the amplitude of the daily range at Vienna has steadily increased during the interval 1878 to 1884 following closely the sun spot numbers. Table IV containing the mean monthly declination for every month from January 1874 to December 1883 is a valuable one. The declination, it appears from this table, is rapidly declining, having started at 10° 38′.8 (E or W?) in January 1874 and diminished to 9° 38′.6 in December 1883, a diminution of almost exactly 1° in ten years or 6′ annually. The mean declination for the years 1874-1883 corresponding to the epoch 1879.0 is 10° 11′.3 (E or W?).

In the study of disturbances the usual methods have been followed. The synodic rotation period of the sun is found from these observations to be 26.00 days, "exactly the same value as that previously found from a study of magnetic and of barometric observations." MARCUS BAKER.

WASHINGTON, Nov. 5th.

(168) **Magnetical Observations made at the Honorable East India Company's Observatory at Madras, under the superintendence of W. S. Jacob, Esq., F. R. A. S., astronomer to the Honorable Company, in the years 1851-1855. Published by order of the Madras government. Madras: Printed at the Lawrence Asylum press by W. H. Moore, 1884.** 4°, vi, 247 pp.

To the great revival of interest in the study of terrestrial magnetism, due chiefly to the researches of the illustrious Gauss, we are indebted for the establishment of magnetic observatories in various parts of the world. One of the earliest of the English colonial observatories, though not *the* oldest, as stated in the volume before us, was established by the East India Company at Madras, where observations began in March, 1841.

The volume before us contains the observations in detail for the five years, 1851-1855, and consists of 247 pages of tables and an introduction of four pages by N. R. Pogson, government astronomer. These four pages of letter press—all there is in the volume—are strikingly different from the ordinary detailed, systematic and prosaic description of instruments, observations, methods, computations, etc., usually found in similar situations.

We commend this departure from usual methods to the careful study of all interested in scientific methods. These peculiarities will be best appreciated, perhaps, by reproducing certain of them as samples.

It appears that the observatory was established and observations begun, as already stated, in March, 1841, by Captain (afterwards Major-General) S. O. E. Ludlow, who remained in charge for some years. Upon returning to England he took with him the original records and computations for the five years, 1841-1845, with the view of working up and publishing them. Years elapsed, however, without this being done and finally, so the record runs, the whole was sent back to the head native assistant, R. Ramanajooloo, who had made most of the observations and computations.

Concerning this act the government astronomer who writes this introduction, remarks that these papers "should have been sent to the government astronomer instead of to one of his assistants." These observations (1841-1845) are still unpublished, and "will require careful revision before they can be considered ready for publication." The observations for the *second* five years, 1846-1850, "were published by Captain Jacob in 1854," the calculations and press revisions, "however, were the work of the same head assistant Ramanajooloo The *third* five-year series "of observations, 1851-1855, are contained in the volume before us issued in 1884, and the printing of which began in July, 1860 (!) and the publication of the *fourth* and last five-year series of hourly observations, 1856-1860, is expected to follow in due time.

Attention is drawn to some "remarkable foot-notes by Ramanajooloo completed before my arrival in India" An examination of these notes reveals a few full, clear, explicit statements couched in somewhat awkward English.

The forms adopted in the preceding volume are "not in accordance with my own views upon the subject," but "are strictly adhered to."

"The English practice of leaving Nature's works unrecorded on Sundays" is mentioned, together with the defects arising therefrom. "With a questionable view to lighten the labors of the observer, in some years five of the twenty-four hourly observations were omitted during the night" and the "records filled up by dubious interpolations." "Days of imperfect or broken records" due to sickness or "ceremonies incumbent upon the native observers" were entirely omitted from the means. There is too frequently a very needless display of decimals, far in excess of what the observations warranted; a weakness common to many similar scientific labors elsewhere as well as at Madras." Of the induction Inclinometer it is said that "no trace of this instrument remaining in the observatory or in the recollection of anyone now in the establishment, all that can be said concerning it is "that its readings have been retained on term days and days of disturbance only.

The vertical force needle (sic) was of the ordinary construction, 13½

inches long, and its "results were never entitled to any confidence." The Dip observations made every Tuesday and Friday at 6:30 and 11:30 A. M., "were carefully taken and are entitled to consideration, though certainly not reliable to seconds of arc, as given in the printed results."

Determinations of the absolute horizontal intensity were made monthly. "The absurd details of these observations and their reductions in the former volume were beyond endurance, and the printed results in this volume have been considerably abridged, though still carried out to a most unwarrantable extent of mere arithmetical display."

Of six officers who successively had charge of the magnetic observations but one survives, and of nine native assistants who "with rare exceptions" made all the observations and computations, six are dead and the remaining three "incapacitated and oblivious of the past."

Finally, we learn that "the difficulty of publishing arrears of scientific observations, when not one concerned in them can be consulted, is very serious, and must be accepted as an apology for all shortcomings in the present volume."

This apology which we "*must*" accept for "*all*" shortcomings in the present volume will of course include also the shortcomings of this most extraordinary introduction which, let us add, neither benefits nor injures the observations which follow it.

Finally, we close the volume wondering whether these contemptuous comments apply to the observations as here printed or to the original manuscript, and if they apply to the printed page why the objectionable features were so fully retained. MARCUS BAKER.

(169) **A. N. Bell, A. M., M. D.** *Climatology and Mineral Waters of the United States*, 8 *vo.*, 386 *pp.* This volume published by Wm. Wood & Co. is uniform, in style of binding and typographical excellence, with "Wood's Library of Standard Medical Authors," and is the October number of the series for the year 1885. Although published as one of a series mostly medical and surgical, Dr. Bell's work, as the title shows, is germane to the interests of a much larger class of people than that alone pertaining to the medical profession. From the prominent position which the author occupies as a sanitarian it would be natural to infer, as he states in his introduction, that the work was published, to a great extent, in the interest of "health in general." The first four chapters are principally devoted to the consideration of the physical properties of the atmosphere respectively treating, first of its permanent, and secondly of its variable constituents. Considerable attention is given to the subject of ozone in the third chapter. Among the variable constituents ammonia is quite fully considered. Upon this subject Dr. Bell quotes extensively Dr. R. Angus Smith. "If organic matter is everywhere," says Dr. Smith, "the presence of ammonia is everywhere possible, and if that matter is decomposing, ammonia is everywhere. It is now many years since it was observed by

me that organic matter could be found on surfaces exposed to exhalations from human beings; but it is not till now that the full significance of the fact has shone on me, and the practical results that may be drawn from it in hygiene and meteorology. These results are that ammonia may be an index of decayed matter." Farther, he says, "by this means currents from four places have been readily found." Dr. Bell gives, in the same chapter, an excellent *resumé* of the most recent ideas upon the subject of "floating matter in the air." In the succeeding chapter he ably treats of the stability of the local conditions of climate.

In relation to the salubrity of the atmosphere of sea-coast places and ocean air, Dr. Bell says: "The air of insular and sea-coast places is essentially damp, and if such places are beset with accumulated debris and a filthy soil, they are unhealthy in the extreme. But on the contrary if they are free from local contaminating influences, and subject to excessive rainfall, and so situated as not to be exposed to winds that trend with the coast, though the atmosphere be never so damp, such places are not commonly insalubrious. Indeed the heavy rains of some sea-coast places are greatly contributive to the purity of both the atmosphere and soil; and, in cold latitudes especially, the moderating influences of the sea on the temperature renders them not only more endurable, but, as measured by results, more salutary for invalids affected with pulmonary disease than the drier, colder, and more variable temperature of interior places of the same latitude." This is somewhat opposed to the views held by Dr. Dennison who says, "dryness and elevation are the most important elements in the climatic treatment of phthisis," and that "an actually small amount of atmospheric moisture is the most important element in the best climate for phthisis." Dr. Bell refers to the comparative immunity from phthisis of men in the navy, stating that among 750 men in one squadron there were in two years 1,661 cases treated for some disease; and, that of this number only about five tenths of one per cent. were treated for phthisis.

Valuable tabulated statistics and meteorological data pertaining to all sections of the United States are interspersed throughout the volume. One hundred and six pages are given to the subject of sectional climatomatic topography and mineral springs in the United States giving the analysis of the principal mineral spring waters. The author subdivides the subject respectively into that of the Atlantic States, the Mississippi Basin, the Western Highlands and the Pacific Slope.

Considerable space in the volume is given to the consideration of the weather in general of the United States according to recent Signal Service reports.

Relative to the influence of the seasons upon mortality from different diseases Dr. Bell, has incorporated into his book the valuable summary upon this subject by Alexander Buchan and Arthur Mitchell.

In his final conclusions Dr. Bell says, "after all that has now been stated of the effects of the atmosphere in high altitudes or at the level of the sea, the influences of forests and ocean, of sea-coasts and interior places, humidity and dryness, cold and heat, the winds, electricity and ozone, and no matter what of other conditions, the paramount considerations for the promotion of health are an *abundance of pure air and sunshine and out-door exercise.* Without these no climate is promotive of health or propitious for the cure of disease; and with them it is safe to say the human powers of accommodation are such that it is difficult to distinguish the peculiarities of any climate by their joint results on the health and longevity of its subjects." A. W. N.

(170) **D. P. Blackstone.** *The Attraction and the Figure of Equilibrium of a Rotating Fluid Mass, and the Interior Density and Temperature of the Earth.* (From the transactions of the Wisconsin Academy of Science, Arts and Letters). In this pamphlet, containing some 56 pages, the author, by geometrical methods, deduces results which in the main are identical with those obtained by means of the Infinitesimal Calculus. The first of the eight sections into which the work is divided deals with "Spherical Attraction." In brief it is shown that if any point without a sphere be taken as the apex of a system of cones having a common axis which passes through the center of the sphere, the mass of the sphere included between any two of the conical surfaces attracts a particle at the apex with the same force that would be exerted by an equal mass concentrated at the center of the sphere. The demonstration is neat, but if the author had employed the infinitesimal method throughout for this particular method, a much simpler and more elegant course of reasoning would have resulted.

In section II the author makes use of a peculiar property of similar concentric ellipses, to arrive at some new expressions involving the relation existing between the semi-major or minor axes and the eccentricity and any pair of conjugate axes of the ellipse.

If the diameter of any circle be taken as the major axis of an ellipse and also as the minor axis of a similar ellipse; then, if from any point, in the diameter produced, tangents be drawn to the three curves, a line drawn from the common center of the curves to the point of tangency of one ellipse will be perpendicular to the tangent to the other ellipse. The angle which the tangent to the circle makes with the diameter is called θ and is used to determine the position of the conjugate axis.

In the next section the subject of "Outside Ellipsoidal Attraction in Line of the Poles" is discussed in much the same way as in case of the sphere. The resulting expression for the attraction of each conical element of mass contains terms involving the even powers of the eccentricity, each term being multiplied by the corresponding power of sin θ. There being an infinite number of elements of mass, it follows that there must

be an infinite number of values of sin θ. By a very simple process of integration it is shown that the mean value of sin θ for the whole spheroid is a simple fraction, the same is found to be true for the various powers of sin θ. In the final expression, therefore, only the mass, distance and eccentricity are involved. It is to be remarked that as the infinitesimal calculus has been used to obtain the most fundamental data, the method cannot, as claimed, be called a purely geometrical one.

Section IV deals with "Outside Ellipsoidal Attraction in Plane of the Equator." By means of the results obtained in section II a method is found for dividing the ellipsoid into equal wedges having their edges in the same equatorial diameter. The total attraction is then the same as the attraction of all the equal wedges, for which an expression involving as before the functions of the angle θ is found. The same ingenious method of integrating is employed to find the total attraction, and the formulæ are identical with those obtained by other methods. In the next section it is shown that on an oblate ellipsoid the attraction at the poles is always greater than at the equator, and that the reverse is true for a prolate ellipsoid, the mass being assumed homogeneous.

In section VI, "Outside Ellipsoidal Attraction in any direction" is, from the nature of the subject, treated in a very laborious way, both the conical and wedge elements of attraction being employed. The author doubtless expended considerable of the brain force, of which he speaks in the introduction, before the work was brought into the form given.

"The gravity and the figure of a body due to its rotation and the attraction of its component particles" forms the subject matter of section VII; the conclusion is reached that the increase in gravity from the equator to the poles varies as the square of the sine of the *geocentric* latitude.

The investigations and results given in the last section are mostly of a hypothetical or speculative character, and relate to the density and temperature of the earth and other planets. The following are some of the conclusions reached.—The average density of the earth's crust in depth about 130 miles is 2.96 times water, and at the center about 3.05 times that of the crust, or nine times that of water.

The temperature of the earth from surface to center at first increases about 1° C. per 90 feet; but this rate of increase so diminishes that at the depth of 130 miles the temperature becomes about 3,600° C. Thence to the center the rate of increase is so small that the temperature continues nearly uniform.

The earth has yet to contract, radially, about 150 miles to become throughout zero temperature. The tabular data given contain the hypothetical values of the mass, density, ellipticity, gravity, etc., for layers at various depths below the surface. The pamphlet is deserving of being read. There are numerous typographical errors; very little attention seems to have been paid to the proof reading. The type used to designate the various quantities involved in the equations etc., is often of the same font as the ordinary reading matter, a serious drawback to a general survey of the subject. The last trouble, it seems, was beyond the control of the author. S.

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